FACTORS AFFECTING RESULTS OF PRE-EMERGENCE TREATMENTS OF THE SOIL FOR WEED CONTROL IN CORN WITH 2,4-DICHLOROPHENOXYACETIC ACID

BY

FRED WARREN SLIFE

B.S., University of Illinois, 1947
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AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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Weed control is a problem in agriculture all over the world. Unlike insects and diseases, which vary greatly from season to season, weeds must be coped with each year. A recent estimate of the annual loss ascribable to weeds in the United States has been set at 5 billion dollars.

Weed control methods can be divided into two main classes, mechanical and chemical. Mechanical control of weeds includes pulling, hoeing, mowing, cultivating, and burning. These practices alone or in combination have been used since the very beginning of crop production, and they remain the most important mens of controlling weeds.

Chemical weed control is not new. Salt, ashes, and industrial by-products have been used many years. In recent years new hormone-type herbicides have been introduced. These newer herbicides have brought chemical control of weeds into prominence, and chemical control may replace a part, at least, of the control of weeds by mechanical means.

The objective of these studies was to evaluate one phase of chemical weed control in corn. This phase was pre-emergence treatments or treatments made to the soil after the crop seeds have been planted, but before the crop seedlings have emerged. It was hoped that a study of certain basic factors involved in the pre-emergence use of 2,4-dichlorophenoxyacetic on corn would show the practicability of such a treatment on corn as well as determine principles that might apply to other crops.

Materials And Methods

Two field tests were conducted in 1950 and in 1951. These tests were located on the Agronomy South Farm at Urbana,

Illinois. In field test I, the amine of 2,4-dichlorophenoxyacetic acid (2,4-D) was applied as a pre-emergence spray to corn at two-day intervals beginning immediately after planting and continuing until five treatments had been made. The corn had been planted at two depths ν shallow, 1½ to 2 inches, and deep, 3 to 3½ inches, and after each treatment with 2,4-D, artificial rainfall was applied at two rates. The rates of rainfall were .6 of one inch to assimilate a light rain and 1.2 inches to assimilate a moderately heavy rain. The objectives of this test were (1) to study the effect of time of application of 2,4-D amine on corn injury and weed control, (2) to study the effect of the amount of rainfall immediately after 2,4-D treatment, and (3) to study the effectiveness of depth of planting as a means of reducing corn injury from 2,4-D pre-emergence treatments. Characteristics studied in this test were stand of corn, corn height at three times during the growing season, weed stand at three times during the growing season, and yield of grain. Data were analyzed by analysis of variance method.

Field test II was an evaluation of several chemicals for pre-emergence weed control in corn. Chemicals and rates of application used in this test in 1950 were (1) amine of 2,4-dichlorophenoxyacetic acid (2,4-D amine) at 1 and 1½ pounds per acre, (2) isopropyl ester of 2,4-dichlorophenoxyacetic acid (2,4-D ester) at 1 and 1½ pounds per acre, (3) amine of 2 methyl 4 chlorophenoxyacetic acid (MCP amine) at 1 and 1½ pounds of acid per acre, and (4) 2,4-dichlorophenoxyethyl sulphate (EHI) at 4 and 8 pounds per acre.

In 1951 the above chemicals were used at the same rates and two additional chemicals were included in the study. They were polyethylene glycol butyl ether esters of 2,4-dichlorophenoxyacetic acid (2,4-D long chain ester) at 1 and 1½ pounds per acre and chlorophenyl dimethyl urea (CMU) at ¼, ½, 1, and 2 pounds per acre. Characteristics studied in this test were weed stand at three times during the growing season and yield of corn grain. Data were analyzed by the analysis of variance method.

Greenhouse and laboratory studies run in conjunction with

the field tests were (1) effect of 2,4-D on dormant weed seeds, (2) effect of several different herbicides on weed seeds, (3) effectiveness of 2,4-D applied at different stages of weed seed germination, (4) tolerance of germinating corn to 2,4-D, and (5) rate of leaching of 2,4-D ester and 2,4-D amine through soils.

Expermintal Results

Field Test I. 2,4-D applied as a pre-emergence spray to corn at two-day intervals after planting had no effect on the stand, height, or yield of corn grain. Depth of planting corn and amount of artificial rainfall had no measurable or observable effect on the degree of injury to corn plants from 2,4-D applied as a pre-emergence spray. The most effective weed control was obtained with the fourth and fifth treatments, and the poorest weed control was obtained with the first application immediately after planting. Pre-emergence sprays seem to be most effective when applied just as the weed seeds are germinating.

Field Test II. All chemicals studied in this test gave excellent weed control except CMU when applied at ¼, ½, and 1 pound per acre. At 2 pounds per acre CMU controlled weeds as effectively as the other chemicals. EHI at 8 pounds per acre gave some reduction in yield of corn grain due to the fact that the treatment reduced the stand of corn. Four pounds of the sme chemical did ont injure the corn and gave excellent weed control. This test indicates there are a number of herbicides that can be used safely as pre-emergence sprays in corn.

Effect of 2,4-D on dormant weed seeds. Freshly harvested seeds of *Setaria lutescens* and *Ipomoea purpurea* were soaked in different concentrations of 2,4-D for different lengths of time. After soaking the seed, dormancy was broken by alternating the temperature 20° above and 20° below freezing for nine months. The *Ipomoea purpurea* seeds were much more sensitive to 2,4-D than were the seeds of *Setaria*

lutescens. *Ipomoea purpurea* seeds were killed by soaking in 2,4-D for 21 days at 250 p.p.m., while *Setaria lutescens* seeds were not killed until they had soaked 21 days in 1,000 p.p.m. concentration of 2,4-D.

Effect of serveral different herbicides on germinating weed seeds. Seven different chemicals were tested for their toxicity to germinating seeds of *Brassica arvensis* and *Abutilon theophrasti*. These seeds were soaked for different lengths of time in different concentrations of these chemicals. 2,4-D ester seemed to be slightly more toxic to the seeds than 2,4-D amine, MCP amine, 2,4-D long chain ester, 2,4-D acid, and 2,4,5-trichlorophenoxyacetic acid. The least toxic chemical was sodium trichloroacetate.

Effectiveness of 2,4-D applied at different stages of weed seed germination. Weed seedlings of *Setaria lutescens* and *Ipomoea purpurea* were placed in different concentrations of 2,4-D for one hour. Four different stages of seedling development for each weed were used in this test. The stages were (1) dormant seed, (2) seed swollen and seed coat cracked, (3) radicle 5 mm. long, and (4) radicle ½ inch long. The seeds of *Setaria lutescens* were much more resistant to 2,4-D than were the seeds of *Ipomoea purpurea* at all four stages. Seeds of both species were more susceptible to 2,4-D injury just after the seed coat had ruptured than they were at any of the other stages in the germinative processes.

Tolerance of germinating corn to 2,4-D. When 2,4-D was applied to soil in different pots at two-day intervals beginning with date of planting, it was found that the treatment decreased root length, root weight, and top development compared with corn growing in soil which had not been treated. The inhibition was most severe when the 2,4-D was added immediately after planting and was progressively less severe with each succeeding treatment date.

Rate of leaching of 2,4-D ester and 2,4-D amine through soils. 2,4-D ester and 2,4-D amine were infiltrated into a black clay loam and a sandy soil. Growth of cucumber seedlings

in one-inch layers of the infiltrated soils indicated the 2,4-D amine moved readily through three inches of both the sand and clay and was found in the filtrate. The ester form did not move through the soils as readily as the amine and was held in the top layer of sand more so than in the black clay loam soil.

Discussion And Conclusions

Pre-emergence treatments for weed control in corn carried out in this experiment were very successful in controlling annual weeds. Delayed application of 2,4-D as a pre-emergence spray gave much better weed control than treatments made immediately after planting. Greenhouse studies showed delayed pre-emergence treatments to be much less injurious to corn than treatments made immediately after planting. Field studies showed no injury to corn from pre-emergence sprays applied at different dates after planting.

Corn planted at two depths was not affected differently by 2,4-D used as a pre-emergence treatment.

Two rates of artificial rainfall applied after pre-emergence treatments at different times after planting did not affect weed control or growth and yield of corn.

Pre-emergence treatments made at six and eight days after corn planting completely controlled weeds all season long, eliminating the need for corn cultivation to control weeds.

2,4-D amine, 2,4-D long chain ester, MCP amine, and 2,4-D ester when used at the rate of 1½ pounds of acid per acre and applied as a pre-emergence treatment on corn gave excellent weed control all season long with no reduction in yield of grain. EHI at 4 pounds per acre and CMU at 2 pounds per acre gave the same results as the above chemicals did at lower rates.

Dormant weed seeds of *Setaria lutescens* and *Ipomoea purpurea* were killed by soaking in 2,4-D solutions before being placed in a refrigerator to break dormancy. Higher concentrations of 2,4-D were needed to kill the seeds of *Setaria*

lutescens than those of *Ipomoea purpurea.*

Seven chemicals were tested for their toxicity to seeds of *Abutilon theophrasti* and *Brassica arvensis.* TCA was the least toxic, while 2,4-D amine, 2,4,5-T amine, MCP amine, 2,4-D ester, 2,4-D long chain ester, and 2,4-D acid were of equal toxicity, except that the 2,4-D ester was slightly more toxic than the rest.

Seedlings of *Setaria lutescens* and *Ipomoea purpurea* were exposed to different concentrations of 2,4-D at different stages of germination and seedling development. *Setaria lutescens* seedings were more resistant to 2,4-D than were seedlings of *Ipomoea purpurea.* Seedlings of both weeds seem to be most susceptible to 2,4-D when the seed coat is cracked and when the radicle is approximately 5 mm. long than at earlier or later stages.

The amine formulation of 2,4-D moved readily through sand and black clay soil in leaching tests, while the ester form remained in the surface layers, indicating that 2,4-D esters are safer for pre-emergence sprays in corn.

VITA

The author was born on a farm near Milford, Illinois, on November 6, 1923. He attended rural school near Milford and in 1941 was graduated from the Milford Township High School. He entered the University of Illinois in the fall of 1941 and completed one year of study in the College of Agriculture.

In January of 1943 he entered the Army of the United States. While in the Army, he completed the basic engineering course in the Army Specialized Training Program at New York University. In August of 1944, he was sent overseas with the United States Infantry and served in the European Theater.

He was discharged from the Army in June of 1945 and re-entered the University of Illinois in the fall of that year. In 1947 he completed his work for the B.S. degree, which was conferred upon him with College honors. He immediately entered the Graduate College at the University of Illinois and accepted an appointment as Assistant in Crop Production in the Department of Agronomy. In June of 1949 he received his Master of Science degree from the University of Illinois and was appointed Instructor and First Assistant in Crop Production at the same institution. He has held this position for three years.

He is the author or co-author of five scientific and 10 popular articles.

He is a member of Gamma Sigma Delta, Sigma Xi and the American Society of Agronomy.

He is married and has two daughters and one son.